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Research Commentary

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Evaluating the Impact of the Connect the Grid Act for Texas

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Introduction

In February 2021, an extreme winter storm in the Southern portion of the U.S. caused generator outages and rolling blackouts in Texas and neighboring states. The economic damage and loss of life resulting from a severely impacted grid brought attention to the importance of long-term planning and generator and transmission infrastructure development. The Electric Reliability Council of Texas (ERCOT) grid was in particular focus as its system in Texas experienced the worst of Winter Storm Uri.

Winter Storm Uri in 2021 exposed some of the vulnerabilities of the ERCOT grid. While freezing temperatures resulting in generator outages and derates were the main culprit, the lack of interregional transmission between Texas and its neighbors was also apparent (FERC, 2021). It meant power couldn't be transferred from SPP, MISO, and the Western Interconnect in the critical hours where load shed occurred (Levin et al., 2022). In order to avoid such events from happening again, the Connect the Grid Act (H.R.7348) was proposed in the U.S. Congress to ensure that Texas gains the capability to import electricity, especially during extreme weather events. It would require ERCOT to meet a pre-defined range of interregional transfer capabilities with its three neighbors by 2035 (Casar, 2024). These requirements are: between 4.3 to 12.6GW with SPP, 2.5 to 16.2GW with MISO, and 2.6 to 7.9GW with the Western Interconnect. In this research commentary, we summarize the results of current work-in-progress centered around the provisions of the Connect the Grid Act.[1] The intent of this commentary is to contribute to the conversation around the benefits of interconnecting the U.S. – ERCOT in particular – and its role in a more resilient, cleaner, and cost-efficient U.S. grid.

Our analysis uses the capacity expansion model GenX.[2] We model the continental U.S. using

[1]Results presented here are preliminary and will be updated accordingly in the working paper. We expect insights to be the same.

[2]GenX is a capacity and transmission expansion optimization tool developed at the MIT Energy Initiative (Jenkins and Sepulveda, 2017). Its objective is to minimize total system cost.

the same data and methods as Botterud et al. (2024) for 2035, which entails dividing the U.S. into 64 zones and then grouping them into 11 transmission planning regions (see Figure 1). Modeling the entire U.S. allows us to explore the impact of connecting the Texas region to the rest of the U.S. on system-wide metrics such as cost and emissions. In this model, ERCOT is represented by Texas, SPP is represented by Central, MISO is represented by Midwest, and the Western Interconnect is represented by Southwest.

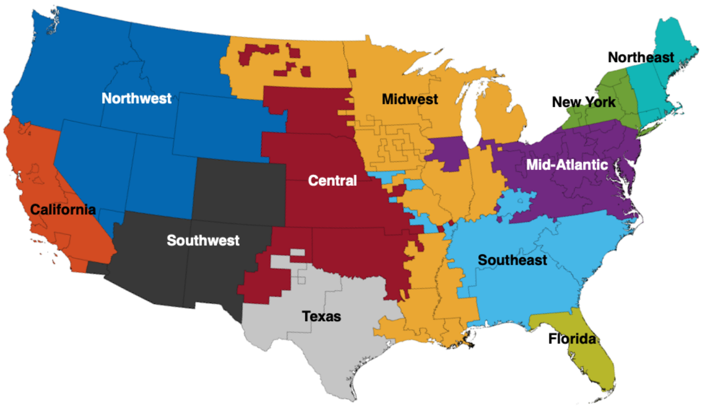


Figure 1: 11 Model Regions Aggregated from 64 IPM Zones

We focus our analysis of the Connect the Grid Act around four themes: (1) transmission requirements, (2) resiliency to extreme weather events, (3) U.S. and Texas cost savings, and (4) climate benefits. The analysis compares two types of systems: one where there is an interregional transmission requirement for Texas and another without one. The Connect the Grid Act includes a lower-bound and an upper-bound transfer capability requirement for Texas with each of the three neighboring regions. So, the first two interregional transmission requirements we assess are one in which the lower-bound capability is required for each neighboring region, and another in which the upper-bound capability is required for each neighboring region. We call these the "CTG Low" and "CTG High" scenarios, respectively. Then we assess two other scenarios with the same total transfer capability as the CTG Low scenario and the same as the CTG High scenario, except that in these two we allow the allocation of total transfer capability among the three neighboring regions to vary as our modeling suggests is optimal instead of as the Act prescribes. We call these the "CTG Low Opt" and "CTG High Opt" scenarios, respectively. Finally, we sweep across a large range of possible total interregional transfer capability, from 5 GW—which lies below the Connect the Grid Act's lower bound—to 60 GW—which lies above the Connect the Grid Act's upper bound. For each total, we assign the capability to the neighboring regions our model suggests are optimal.

We now proceed with the summary of our evaluation of the Connect the Grid Act, answering questions related to each of our main themes.

1. What are the optimal transfer capability requirements?

Table 1 compares the regional transfer capability of CTG Low Opt and CTG High Opt with transmission requirements of the CTG Low and High scenarios. In the CTG Low Opt scenario, more transmission will be required in the Southwest. Meanwhile, more transmission will be required in Central in the CTG High Opt scenario. Figure 2 shows the optimal transfer capability between Texas and its neighboring regions for different total transmission requirements. At requirements below 15GW, the Southwest sees the largest share of transfer capability. Between 20GW and 35GW, the optimal would be to build more transmission between Texas and Central. Beyond 35GW, more transmission should be built between Texas and the Midwest.

Table 1: Distribution of Transmission Requirements for the Low and High Scenarios (in GW)

	Low		High	
	CTG Low	CTG Low Opt	CTG High	CTG High Opt
Central	4.3	1.7	12.6	19.5
Southwest	2.6	6.2	7.9	9.8
Midwest	2.5	1.5	16.2	7.4
	9.4	9.4	36.7	36.7

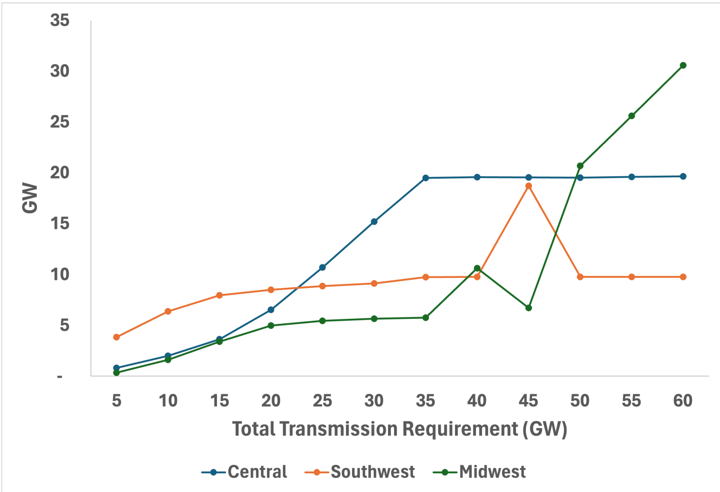


Figure 2: Optimal Transfer Capability to each of Texas' Neighboring Regions

2. Does the Connect the Grid Act help prevent the impact of Extreme Weather Events?

One of the main motivations for the proponents of the Connect the Grid Act is its mitigating effect on the impact of extreme weather events like Winter Storm Uri. To quantify this effect, we use a similar methodology as Botterud et al. (2024) and simulate 1,000 random outages in Texas under a 2035 system with different transmission requirements. The random outages are at the same scale as Winter Storm Uri across five days.[3] In each simulation, we assume that a set percentage similar to the outages experienced during Winter Storm Uri for each type of generator technology cannot produce power – 43% coal, 21% nuclear, 7% PV, 46% wind, and

[3]From Feb 13 to 17, equivalent to 120 hours

50% natural gas (Levin et al., 2022; Busby et al., 2021; FERC, 2021).[4] We also scale hourly load to mimic the load increase experienced during Winter Storm Uri (see Appendix A).[5]

Figure 3 illustrates the outage distribution at each requirement level.[6] We find that transmission requirements lead to 43% fewer affected households when the requirement is 10GW and by 82% when the requirement is 50GW. Overall, as transmission requirements increase, the amount of affected households during extreme weather events also decreases. In the current provisions of the Connect the Grid Act, CTG Low leads to an average of 48% fewer household outages from an average of 5.75 million households to 2.99 million households, and CTG High leads to 79% fewer affected households from 5.75 million to 1.21 million.

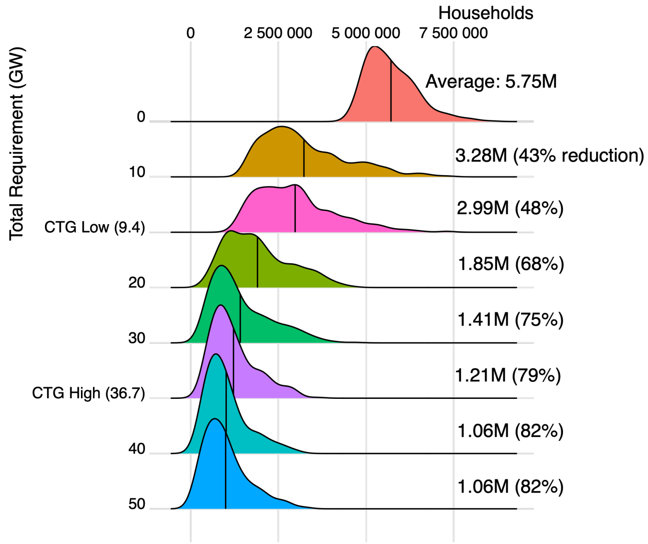


Figure 3: Distribution of Simulated Outages per Transmission Requirement

Figures 4a to 4f show the simulated range of gross imports into Texas per hour of the extreme weather event. For low values of transfer capability, the maximum import is equal to the transfer capability (i.e., 0.82 GW in Figure 4a, 9.4GW in Figure 4b, and 10GW in Figure 4c). This indicates that more transmission will benefit Texas as it would allow for more electricity imports into the region. However, when the transfer capability requirement is at 20GW or larger, we find that the imports are capped at 18 to 22GW. This is because of the increase in load in neighboring regions, which also constrains its generation capacity. This provides some evidence to show that transmission, while important to increase grid resiliency during extreme weather events, must be coupled with generation capacity that can be accessed during these events. We

[4] Our method does not account for hour-specific outages, which occurred during Winter Storm Uri. Instead, we assume that the outage occurs throughout the entire duration. This is why we see larger average outages in our simulation.

[5] We scaled the 2035 load data for Texas, Central, and Midwest according to the increase that it would have experienced under a storm similar to Winter Storm Uri. To do so, we calculated the percentage scale of each hourly load from Feb 13 – 17, 2021, relative to the average of each hourly load in 2019, 2020, and 2022. In the hours where load shed occurred, we used forecasted load as the basis for scaling (ERCOT, 2021; King et al., 2021). In the hours when no load shed occurred, we used actual load data from the EIA (EIA, 2024).

[6] An output of one simulation is non-served energy (i.e., curtailed load) per hour. We can then take the total non-served energy and divide it by 120 hours to get the average curtailed load across the entire duration of one simulation. The average of this value across 1,000 simulations is then calculated, and multiplied by 670 (where we assume 1MW is enough to power 670 households) arriving at the average value in Figure 3.

note that during Winter Storm Uri, peak load shed was at 20GW. With enough generation capacity in its neighboring regions and transmission requirements between 20 to 30GW, this load shedding scenario could have been avoided.

3. How much will the Connect the Grid Act save?

In a normal weather year without any extreme events, the Connect the Grid Act leads to annual U.S. system cost savings of $901 million for the CTG Low scenario and $1.24 billion for the CTG High scenario relative to not implementing the Connect the Grid Act (No CTG scenario). With a redistribution of the total requirements to get the system cost optimal, there are additional savings of $183 million in the CTG Low Opt scenario and an additional $28 million savings in the CTG High Opt scenario. The transmission requirement that leads to the optimal U.S. system cost is 20GW, which leads to savings of $1.5 billion. These savings are primarily driven by avoided capacity investments, fixed operating and maintenance, and fuel costs in Texas' neighboring regions. Figure 5 shows the total annual system cost at varying transmission requirement levels.

We also calculate the cost allocation to Texas and assume that cost is allocated to the region where power is generated. Furthermore, we assume that investments in transmission lines are allocated based on the region's usage of the line. Figure 6 shows both Texas' cost allocation and capacity mix. We see that having transmission requirements leads to a larger cost for Texas. The cost allocation increases with a larger transmission requirement until it levels off at 30GW. This cost increase is a consequence of more generation capacity, particularly Wind with an additional 17GW of capacity starting at a 20GW transmission requirement.

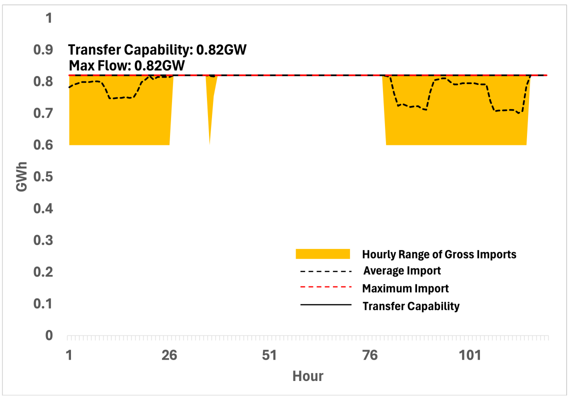
The additional transmission and generation capacity increases cost for Texas but also makes the region an exporter of clean energy. This results in more revenues, and therefore higher *Revenue – Cost* as shown in Figure 7.[7] Revenue – Cost is larger than the case without the Connect the Grid Act for requirements above 20GW by an average of $308 million annually across the requirements. At 20GW where the optimal system cost is obtained, Texas' Revenue – Cost is smaller by $28 million. At the CTG Low scenario, Revenue – Cost is smaller by $141 million, but it is larger by $123 million in the CTG High scenario.

4. What are the climate benefits of the Connect the Grid Act?

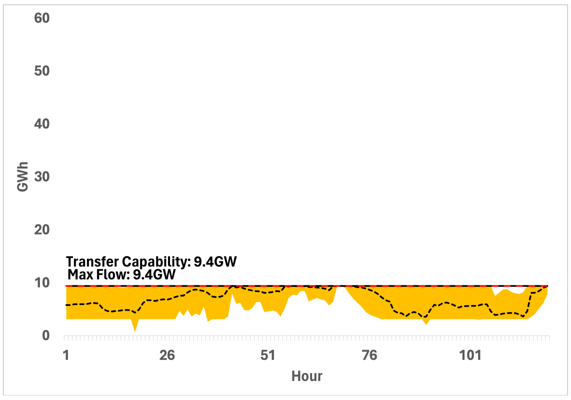
The Connect the Grid Act leads to annual system-wide reduction of 12.8Mmt (million metric tonnes) and 31.1Mmt of CO_2 emissions for the CTG Low and High scenarios, respectively. This translates to $2.44 and $5.91 billion in additional annual savings based on the EPA's most recent proposed social cost of carbon of $190 per metric tonne (EPA, 2023). Similarly, Texas sees an annual reduction of 11.47Mmt and 13.24Mmt for the CTG Low and High scenarios. This is equivalent to $2.18 and $2.52 billion in additional savings.[8]

[7] We refrain from calling Revenue – Cost as *Profit*. Perhaps a more appropriate term is *Net Revenue*, *Producer Surplus*, or *Quasi-rent*. In any case, a higher Revenue – Cost is beneficial for Texas.

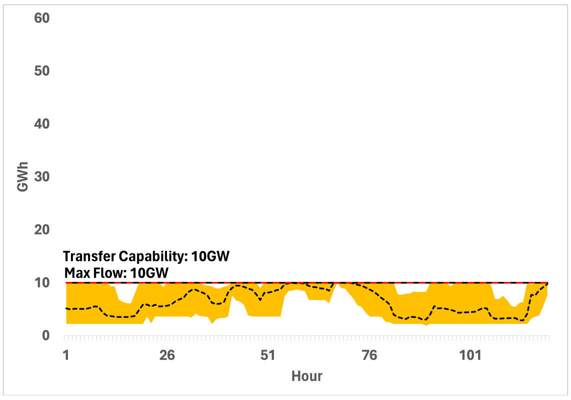
[8] We assume that emissions are allocated to the region where power is generated.



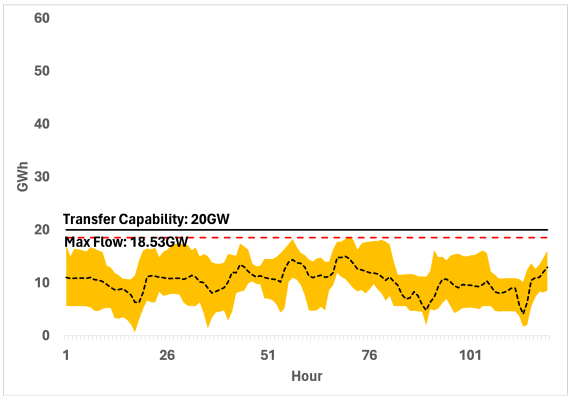
(a) No CTG



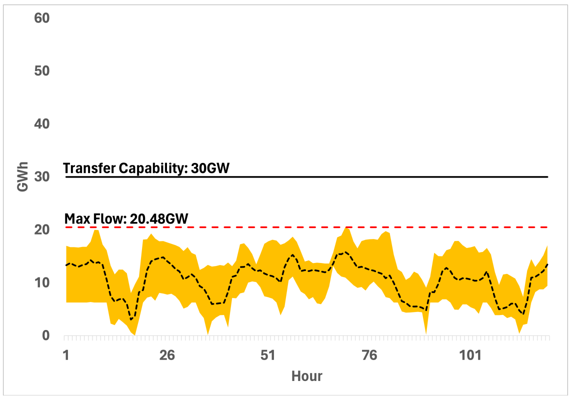
(b) CTG Low (9.4GW)



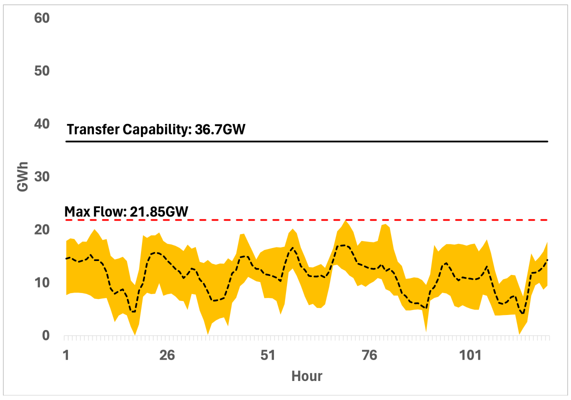
(c) 10GW Requirement



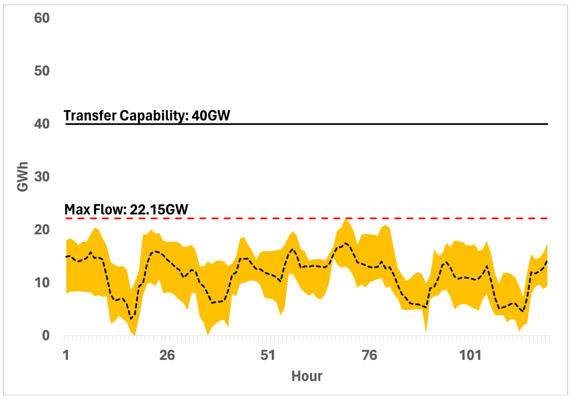
(d) 20GW Requirement



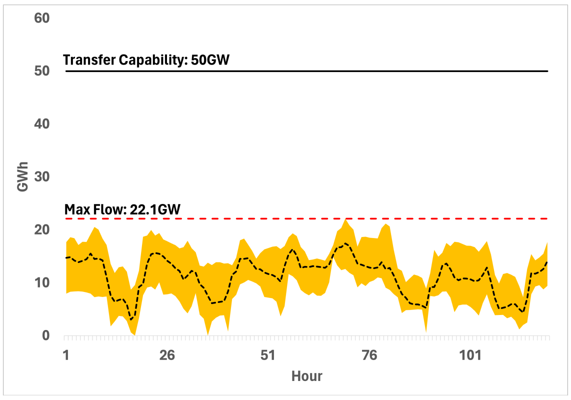
(e) 30GW Requirement



(f) CTG High (36.7GW)



(g) 40GW Requirement



(h) 50GW Requirement

Figure 4: Simulated Range of Gross Imports into Texas per hour during the Extreme Weather Event

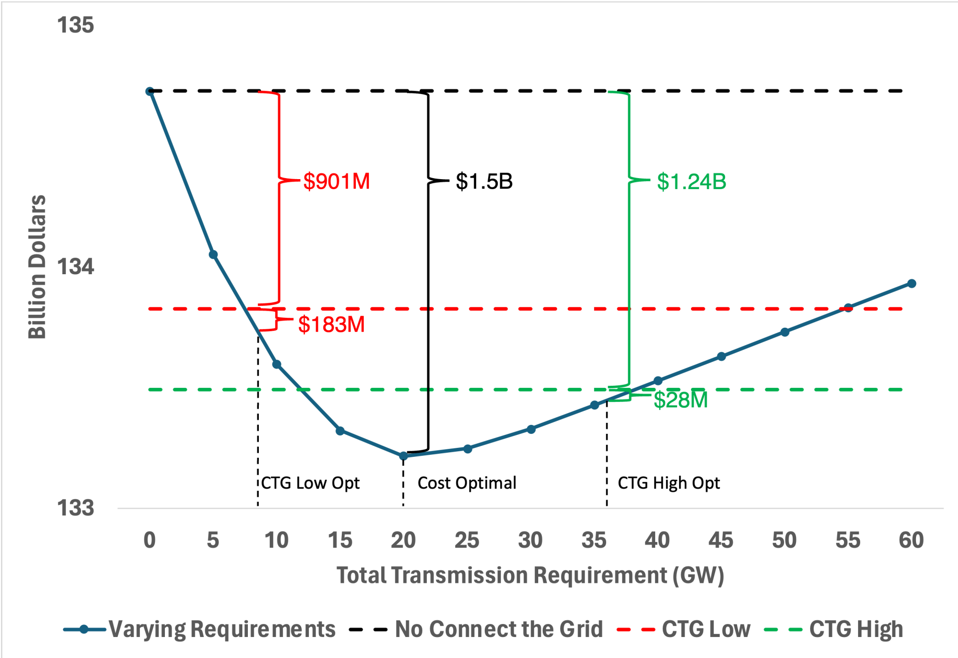


Figure 5: Total Annual U.S. System Cost

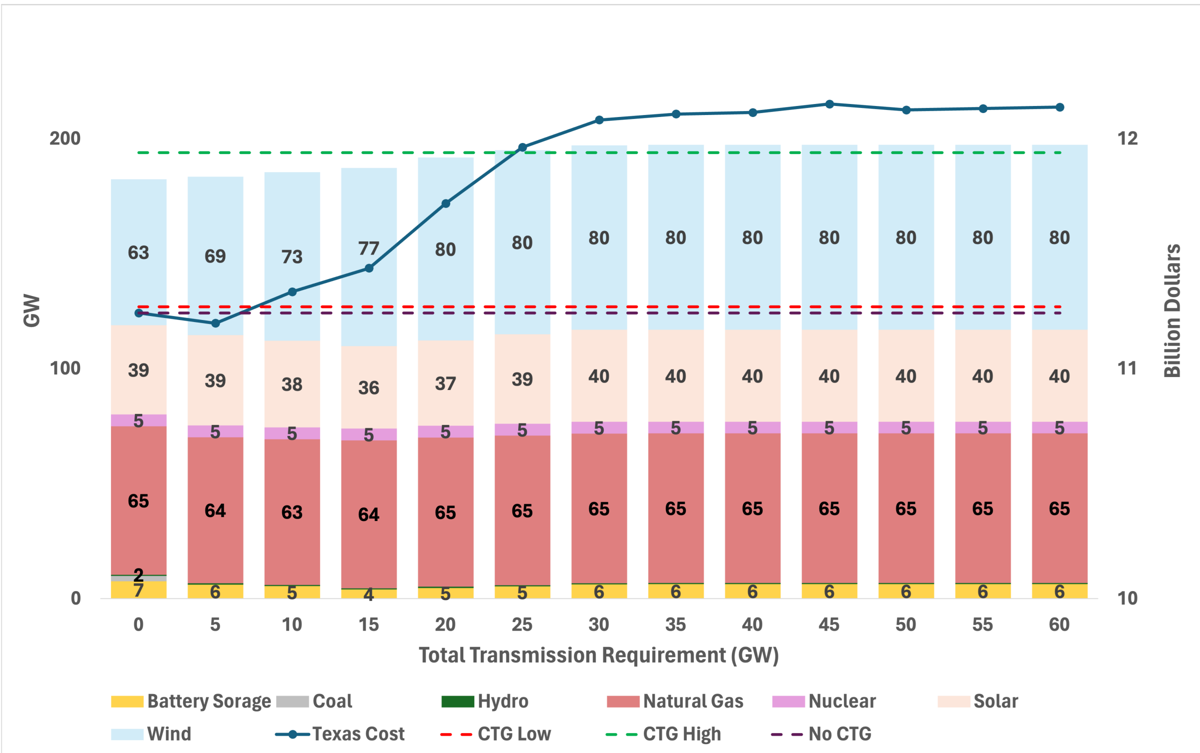


Figure 6: Texas Cost and Capacity Mix

Figures 8a and 8b show Texas and system-wide emissions at varying requirements. Even relatively small transmission requirements of 5GW lead to significant climate benefits with a 10Mmt CO_2 emissions reduction in Texas and a 12Mmt reduction system-wide. Texas' climate benefits level off at the 15GW mark where it exhibits similar emissions as both the CTG Low and High scenarios. The U.S.' climate benefits level off at the 20GW mark, exhibiting similar emissions as the CTG High scenario.

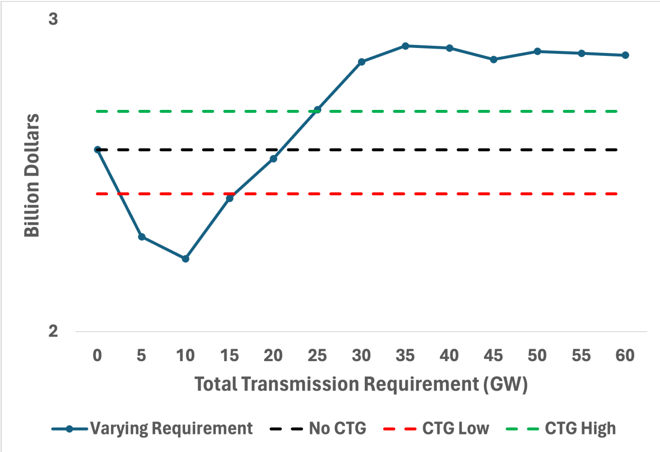
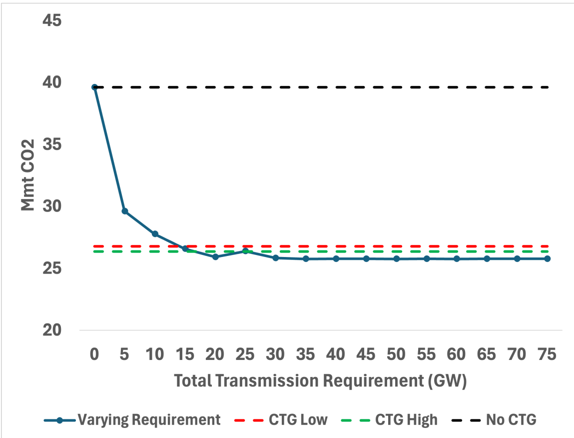
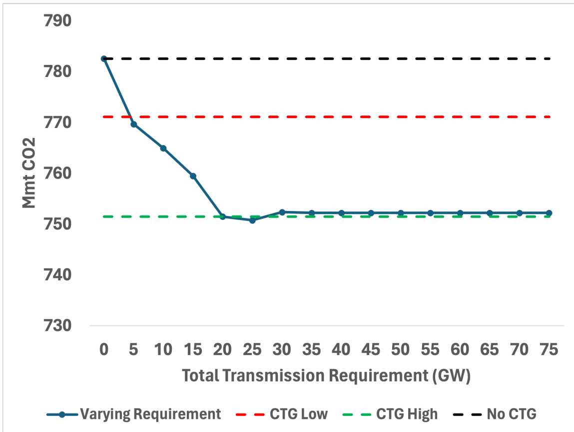


Figure 7: Texas Revenue – Cost



(a) Texas Emissions



(b) U.S. System-wide Emissions

Figure 8: Texas and System-wide Emissions per Total Requirement

Conclusion

In this research commentary, we summarize the preliminary results of our evaluation of the Connect the Grid Act, a legislation that would require ERCOT to establish transfer capabilities to its neighboring regions. We used the capacity expansion model GenX to compare systems with and without the Connect the Grid Act, analyzing its current provisions as well as variations of its requirements. Our main findings are:

- The Connect the Grid Act would increase grid reliability during extreme weather events. In a simulation of a storm similar in profile to Winter Storm Uri, the Connect the Grid Act leads to 48% fewer households in the low requirement scenario and 79% fewer households in a high requirement scenario. Varying the requirements show that more transmission leads to fewer outages.

- The Connect the Grid Act would reduce total U.S. system cost by $901 million annually in the bill's low requirement scenario and $1.24 billion annually in the high requirement scenario. An optimal redistribution of the required transfer capability between Texas and its neighboring regions provides additional savings of $183 million annually in the low requirement and \$28 million annually in the high requirement scenarios. A requirement of 20GW provides the optimal system cost with savings of \$1.5 billion annually.

- The Connect the Grid Act leads to an increase in Texas' annual cost because of the larger investment in wind generation capacity. Texas becomes an exporter of clean energy and it sees its annual revenues increase at a larger rate than its cost in transmission requirements of 25GW or more.

- The Connect the Grid Act leads to annual system-wide CO_2 emissions reduction of 12.8 to 31.1Mmt and annual Texas CO_2 emissions reduction of 11.47 to 13.24Mmt.

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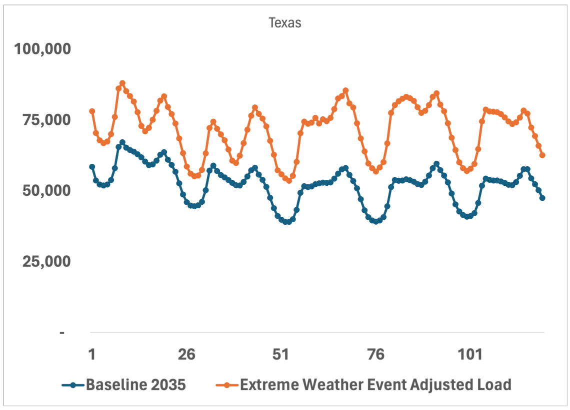
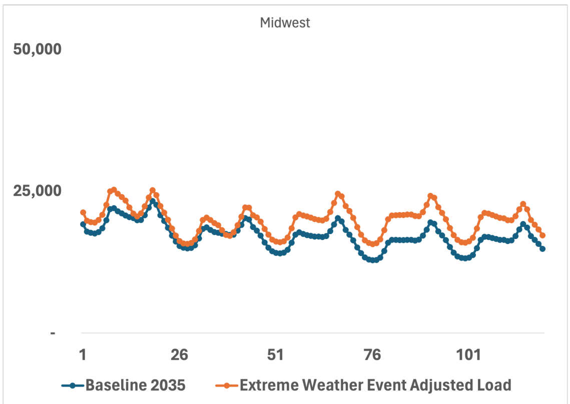
Appendix A. Hourly Load and Rate of Increase for Extreme Weather Event Analysis

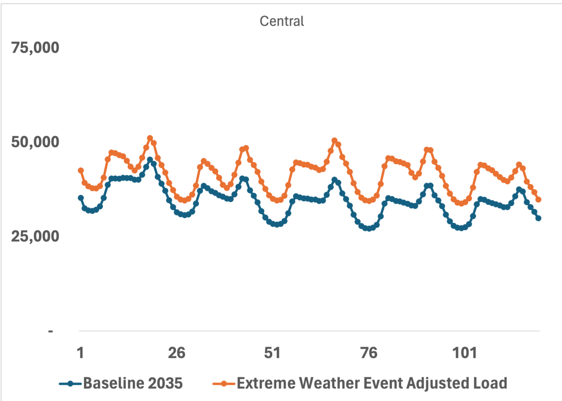
Figures A.9a to A.9c show the increase in load from the baseline 2035 values. Note that for the Midwest and Central, we only scale the load of specific zones and not the entire region. The values displayed in the figures are the total load of these affected zones.



(a) Texas



(b) Midwest



(c) Central

Figure A.9: Baseline and Extreme Weather Event Adjusted Load

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